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Chapter · July 2021

DOI: 10.2307/j.ctv1tfw0z6.16

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Chapter Title: Resplendent Innovations Fire Gilding Techniques at the Qing Court
Chapter Author(s): Te-cheng Su and Hui-min Lai

Book Title: Making the Palace Machine Work
Book Subtitle: Mobilizing People, Objects, and Nature in the Qing Empire
Book Editor(s): Martina Siebert, Kai Jun Chen, Dorothy Ko
Published by: Amsterdam University Press. (2021)
Stable URL: https://www.jstor.org/stable/j.ctv1tfw0z6.16

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5 Resplendent Innovations

Fire Gilding Techniques at the Qing Court

Te-cheng Su and Hui-min Lai

Abstract
This chapter investigates how the innovation of fire-gilding techniques by the Imperial Household Department helped integrate political and religious power within the empire. During the Qianlong reign (1736-1795), Tibetan style *sisa* forging, rubia cordifolia burnishing, and multi-layered gilding techniques were introduced while equipping temples with resplendent brass roof tiles and gilded artefacts. The sophistication of manufacturing gilded copper objects relied on the multicultural exchange with Nepalese, Tibetan, and Xinjiang handicrafts. It also required careful management of the flow of such precious materials as gold and copper as well as the necessary labour resources in the form of skilled court and contract artisans.

Keywords: Qianlong emperor, fire gilding, metal manufacturing, multiculturalism, Tibetan style

Introduction

The technology of gold plating, which enjoyed a long history in China, witnessed significant breakthroughs in both materials and techniques in the mid-18th century, during the reign of the Qianlong emperor. The context of these innovations was politico-religious in nature and stood in close connection with the conquest of the former Mongolian region of Dzungaria in Central Asia in 1758. This conquest not only expanded the territory of the Qing empire considerably but also furthered the Qianlong emperor's (r. 1736-1795) attempt to find ways to integrate political and religious power within the empire.

Siebert, Martina, Kai Jun Chen, and Dorothy Ko (eds), *Making the Palace Machine Work: Mobilizing People, Objects, and Nature in the Qing Empire*. Amsterdam, Amsterdam University Press 2021
DOI: 10.5117/9789463720359_CH05

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How the empire ruled different peoples across its large territory has aroused much interest amongst historians in recent years.[1] This chapter contributes to this debate by investigating a nexus of technology, religion, resources, and knowledge management, whose reins lay in the hands of the Imperial Household Department at the core of the 'palace machine'. These activities aimed to culturally bind the new Mongol subjects to China by re-enacting the religious culture of the imperial periphery in the power centres of the empire. A prominent example of this is the copy of the Potala Palace in Lhasa, Tibet, residence of the Dalai Lama and religious centre for the Mongols and Tibetans, which was built at the imperial summer residence in Chengde. In an effort to attract the Mongols to China on pilgrimage, Qianlong built temples outside Tibet in the Tibetan style, equipped with resplendent brass roof tiles and gilded artefacts.[2] This chapter examines the sophisticated process of manufacturing fire-gilded artefacts needed for this endeavour at the Qing Imperial Workshops, control of the material flows of the precious metals, and the European and Tibetan influences on this technology. As the discussion below makes clear, this workflow, knitted together from old and new parts of the palace machine, came into fruition during the Qianlong reign.

Gold, the key ingredient of fire gilding, was a precious commodity whose sourcing and movement through the palace machine were strictly controlled and meticulously logged. The Bullion Vaults of the Grand Storage Office (*Guangchusi Yinku* 廣儲司銀庫) of the Imperial Household Department (*Neiwufu* 內務府) was responsible for handling imperial finances and stocking all the treasures collected by the emperors. The stockpile of gold held by the Imperial Household Department was also stored in the Bullion Vaults. The deposit was regularly augmented by annual tributes of gold from the peripheral areas which amounted to tens of thousands of taels, far exceeding those received by individual European kings in the 18th century. The Bullion Vaults' directors (*tangguan* 堂官) had to present 'monthly reports' (*yuezhe dang* 月摺檔), also known as 'four-column ledgers' (*sizhu*

1 See, for example, the works of Patricia Berger, *Empire of Emptiness Buddhist Art and Political Authority in Qing China* (Honolulu: University of Hawai'i Press, 2003); Philippe Forêt, *Mapping Chengde: The Qing Landscape Enterprise* (Honolulu: University of Hawai'i Press, 2000); Pamela Crossley, *A Translucent Mirror: History and Identity in Qing Imperial Ideology* (Berkeley: University of California Press, 1999); and Peter Perdue, *China Marches West: The Qing Conquest of Central Eurasia* (Cambridge, Mass: Harvard University Press, 2005).

2 Lai Hui-min 賴惠敏, *Qianlong huangdi de hebao* 乾隆皇帝的荷包 (Taipei: Zhongyang yanjiuyuan jindaishi yanjiusuo, 2014). See especially Chapters Five and Seven on the costs of the Qing Court in constructing Tibetan Buddhist temples.

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qingzhe 四柱清摺) detailing the vaults' opening balance (*jiucun* 舊存), new receipts (*xinshou* 新收), actual use (*chuyong* 除用), and closing balance (shizai 實在).[3] (See Chapter Three for the Imperial Household Department's accounting system.)

The flow of materials, labour resources, and their monetary equivalents was managed with care and in accordance with constantly-evolving precedents. When constructing and repairing imperial palaces and gardens, Qianlong set up specific construction offices for each project, such as the Long River Construction Office (*Changhe gongcheng chu* 長河工程處) and the Old Summer Palace Construction Office (*Yuanmingyuan gongcheng chu* 圓明園工程處). Each construction office would have to issue its own 'Current Regulations and Precedents' (*xianxing zeli* 現行則例), detailing the amount and price of raw materials needed for the project, as well as the number of artisans and their salaries. Artefacts were ordered to be manufactured 'according to the precedents on manufacture' (*an chengzao zhi li* 按成造之例). Most of these construction offices' 'Regulations and Precedents' (*zeli* 則例) were compiled during the Qianlong reign, turning these larger building projects into standardizing models and financial orientation for future projects.[4] Qianlong pressed the Imperial Household Department to follow the 'Current Regulations and Precedents'. The *Current Regulations and Precedents on Fire Gilding in the Yangxin Palace* (Yangxin dian dujin zuo zeli 養心殿鍍金作則例) and the *Current Regulations and Precedents on Fire Gilding in the Old Summer Palace* (Yuanming yuan dujin zuo zeli 園明園鍍金作則例) are examples of these kind of documents containing information on the raw materials and artisans required; while the *Current Regulations and Precedents on the Price of Miscellaneous Items* (Zaxiang jiazhi zeli 雜項價值則例) and the *Precedents on Compositions of*

3 *Qianlong chao Neiwufu yinku jinxiang yuezhe dang* 乾隆朝內務府銀庫進項月摺檔 (Microfilm. Beijing: The First Historical Archives of China, 2001).

4 These documents are not datable exactly but were, according to Wang Shixiang's analysis, compiled after finishing the project that gave the regulation its title. Most of the manuscript copies we have today, such as the *Neiting Yuanmingyuan neigong zhuzuo xianxing zeli* 內庭圓明園內工諸作現行則例 (Current Regulations and Precedents on the interior handicrafts in the Inner courts of the Yuanmingyuan) or those concerning the building of the palaces at Rehe date from Qianlong's time; the regulations excerpted from the building project of the Yuanmingyuan and Wanshou shan 萬壽山 palace gardens and the Inner Palaces (*neiting* 內庭) date from after that time. Before Qianlong reign the only existing orientation for projects was the *Gongcheng zuofa* 工程做法 compiled in the 22nd year of Yongzheng (1734) by an editorial team headed by Yunli 允禮 (1697-1738). Wang Puzi 王璞子 annotated it and published a modern edition. See also Wang Shixiang 王世襄, ed., *Qingdai jiangzuo zeli* 清代匠作則例 (Zhengzhou: Daxiang chubanshe, 2000).

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Materials (Wuliao jinliang li 物料舡兩例) provide valuable information concerning the price of raw materials and the formulas of various mixtures.[5] Taking these regulatory and other archival sources together, supplemented by actual extant artefacts, this chapter scrutinizes fire gilding as a case study to illustrate the complexity and meticulousness of managing manufacture and technical processes in the palace workshops, as well as the multicultural exchange between Chinese, Tibetan, and European craft knowledge that fuelled the respective technical innovation.

Fire gilding, known in historical Chinese as *liujin* 鎏金, was a chemical gold plating technique developed in China as early as 300 B.C.E. It entailed first combining gold and mercury to make an amalgam paste, which was spread onto the surface of a copper or silver alloy object. The object was subsequently heated to volatilize the mercury, producing a firmly-bonded gilding layer. The descriptions of the process found in historical sources are very similar to how the process is explained by craftsmen today.[6] The *Complete Dictionary of Chinese Crafts* summarized the process into five stages: (i) preparing a gilding-stick (*zuo jingun* 做金棍) to stir the paste and apply the amalgam onto the objects; (ii) melting the gold together with mercury to produce the amalgam (*shajin* 煞金); (iii) applying the gold [amalgam] onto the object (*mojin* 抹金); (iv) 'unclosing the gold', i.e., heating the object to evaporate the mercury so that a gilded layer is formed (*kaijin* 開金); (v) press polishing the object (*yaguang* 壓光).[7] Conservation chemist Kilian Anheuser suggested that a possible variation of this historical technique was to spread gold foil onto a surface coated with mercury, then heat the surface directly.[8]

Traditional fire gilding is a technique that offers several advantages: first, a relatively cheap form of gold, namely gold leaf, and mercury were

5 Jiang Yasha 姜亞沙 et al., eds., *Qingdai gongyuan zeli huibian* 清代宮園則例彙編 (Beijing: Quanguo tushu guan wenxian suowei fuzhi zhongxi, 2011). For *Yangxin dian dujin zuo zeli* see ibid., vol. 5, 327-329; for *Yuanming yuan dujin zuo zeli* see ibid., vol. 18, 355-356.

6 Liang Xudong gave an extended introduction to the different gilding techniques, relying partly on oral reports by craftsmen (Liang Xudong 梁旭東, 'Zhongguo chuantong de liujin jishu 中國傳統的鎏金技術', *Cailiao baohu* 材料保護, vol. 23, no. 1/2 (1990): 83-86. For a short analysis of the history of Chinese gilding technique see also Joseph Needham et al., *Science and Civilization in China*, vol. V: Chemistry and Chemical Technology, part IV, 'Spagyrical Discovery and Invention: Apparatus, Theories and Gifts', (Cambridge: Cambridge University Press, Cambridge, 1980), 80.

7 Wu Shan 吳山, ed., *Zhongguo gongyi meishu dacidian* 中國工藝美術大辭典 (Nanjing: Jiangsu meishu chuban she, 1989), 272.

8 Kilian Anheuser, 'Archaeotechnology: The practice and characterisation of historic fire gilding techniques', *JOM-Journal of the Minerals Metals & Materials Society*, vol. 49 (1997): 58-62.

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used as raw materials and, as both can form gilding layers, it was possible to minimize waste; second, the task can be performed with simple equipment and tools and thus only required low capital investment beyond the raw material; third, any plating flaws in the first attempt can be repaired by a second or even third attempt. Gold amalgam can be easily spread on hollow parts or the interior of blind holes, and this technique is therefore still widely used on silver and hollow copper-alloy jewellery and sculptures today.[9]

The following sections of this chapter will investigate the sources of two essential raw materials used in fire gilding, namely gold and copper,[10] before examining the management of fire gilding artisans. The chapter will then explore two major fire-gilding projects of the Qianlong-era court: first, the gold roofs of the Chengde Potala and second, a set of gilded Buddhist statues for a Beijing temple. Closely connected to the large Chengde project was a change in fire gilding to use copper alloy bodies. Prior to the Qing, fire gilding had largely been applied onto silver objects, which was a relatively simple procedure. The more involved and complex procedure of fire-gilding copper alloys was, as will be shown later, a Tibetan technology introduced to the Qing court by the lama envoys residing in Beijing.

Sourcing Raw Materials used in Fire Gilding for the Qing Court

The Qianlong court went to great lengths to secure a consistent and adequate supply of gold from multiple sources for its gilded politico-religious projects. Gold was the fuel for the sub-unit in the palace machine in this case. An important and steady source of gold during the Qianlong reign was the yearly

9 Electroplating engineers Wu Yuankang 吳元康 and Chu Rongbang 儲榮邦 compared traditional fire gilding to electroplating – the common technique in modern times – and pointed out several benefits of the traditional techniques, see their 'Liudu – zhongguo gudai faming de yizhong zai cailiao biaomian shang du jinshu de jishu 鎏鍍—中國古代發明的一種在材料表面上鍍金屬的技術', *Tuzhuang yu diandu* 塗裝與電鍍, no. 1 (2011): 3-9 and its sequel 'xu wan 續完', ibid., no. 3 (2011): 25-28.

10 China's indigenous resources of mercury are comparatively small and thus, in the 18th century, it was imported via the port of Guangzhou. As *The Chronicles of the East India Company Trading to China, 1635-1834* shows, mercury was one of the major import products of the time. Starting with 64 *dan* 擔 (picul) worth 2,864 *liang* (tael) of silver in 1700 the amount grew yearly by up to 100 *dan*. Several countries were involved in the mercury business with Qing China. By the first half of the 19th century the largest amounts of that metal came from the US – 8,210 *dan* in 1823 and 10,154 *dan* in 1832 worth 492,600 and 629,548 US dollars respectively. See Hosea Ballou Morse, *The Chronicles of the East India Company, Trading to China 1635-1834*, vol. 1 (chapter 6), 69; vol. 4 (chapters 80 and 91), 84 and 339.

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tributes coming from the newly incorporated peripheries of the Qing empire; but ad hoc sourcing via other administrative channels also played a part in feeding the gold-hungry court. In addition, when copperware replaced silverware during the Qing in the fire gilding process, copper of a higher purity had to be imported from Japan to ensure optimal results. Sourcing the materials for fire gilding thus involved new itineraries of materials and new logistical arrangements.

(I) Gold in the court

The Qianlong court's appetite for gold to use in fire gilding was insatiable, and the acquisition of this precious material was enmeshed with the conduct of politics and diplomacy of the empire. During the Kangxi reign the court's main source of gold was tribute gold from Annan 安南, modern Vietnam. The steep rise in the volume of gold flowing into the court began under Qianlong's rule as new sources were tapped, such as regular deliveries of gold from the new Qing territories to the West and gold tributes arriving from vassals and other foreign countries. Generally speaking, gold in the 18th-century Qing court can be distinguished as coming from two sources: inner-Chinese or foreign sources. From the inner-Chinese sources, the largest amount of gold in the period under review here was not obtained from any gold mines but from the pockets of salt merchants, who had to pay fines of 'indulgence gold' (*shuzui jin* 贖罪金) to the Lianghuai Salt Administration, and from the fines of the famous 'Lianghuai Salt Certificate Case' (*Lianghuai yanyin an* 兩淮鹽引案, 1768). Both went to the Imperial Household Department. In 1768, the Lianghuai Salt Supervisor (*yanzheng* 鹽政) Youbashi 尤拔世 handed in 2,988 taels of 'indulgence gold', a fine paid by merchant Hong Zhenyuan 洪箴遠 and others. In the following year, Youbashi sent another ten boxes of gold leaf, amounting to 5,000 pieces and 490 taels in weight in total, this time directly to the Imperial Workshops (*Zaobanchu* 造辦處).[11] The practice of salt supervisors collecting salt merchants' debts and sending them to the Imperial Household Department as gold continued in the years after the Salt Certificate Case. The monthly report for October 1770, for example, reports that 'the touring salt censor (*xunshi changlu yanzheng* 巡視長蘆鹽政) Li Zhiying 李質穎 is obligated to deliver the debt of one million taels of silver in total. From this instalment, 5,000 taels of gold were bought'.[12]

11 *Junjichudang zhejian* 軍機處檔摺件 (Archives of the Grand Council), no. 010831 (QL34/10 = Oct. 1769) (Taiwan National Palace Museum).

12 *Qianlong chao Neiwufu yinku jinxiang yuezhe dang*, QL35/10 = Nov.-Dec. 1770).

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By 1786, the Lianghuai Salt Administration had submitted a total of about 50,000 taels of gold.[13]

Another domestic source of gold was the compulsory annual deliveries by provincial gold refineries to the Board of Revenue (*Hubu* 戶部) in amounts set by the *Precedent Cases of Statutes of the Great Qing* (Da Qing huidian shili 大清會典事例). As a matter of fact, part of this gold was given as a 'tribute' (*gongjin* 貢金) to the Imperial Household Department. Archival documents show that, from 1759 on, the Imperial Household Department received such 'tribute gold' from Yunnan, Guizhou, Shanxi, and Gansu.[14] For instance, in 1759 the provincial governor (*xunfu* 巡撫) of Yunnan Liu Zao 劉藻 and the provincial governor of Guizhou Zhou Renji 周人驥 sent 131.4 and 111.36 taels of gold respectively;[15] thereafter they contributed more than 100 taels annually.[16] Qianlong also ordered the provincial governor of Yunnan to buy gold locally. For example, in 1753 Aibida 愛必達, following an imperial order, bought 1,000 taels of gold in different qualities: 200 taels of 80% gold, 200 taels of 75% gold, and 600 taels of 70% gold. At that time gold was cheaper in the gold-producing province of Yunnan by over 2,000 silver taels per catty than it was in the capital, Beijing.[17]

The Imperial Household Department also procured gold directly from production sites on an ad hoc basis in the form of official gold tax. The sites for gold sand production located in the mountains north and south of Shazhou in Dunhuang, Gansu, are one example. Traces of this gold and how it made its way into the Bullion Vaults (*Yinku* 銀庫) of the Imperial Household Department can be found in the monthly report dated January 1781. There the director of the Bullion Vaults (*yinku langzhong* 銀庫郎中) Bandaersha 班達爾沙 and others registered the following extractions: 19 gold ingots of *zhengkejin* 正課金 (standard gold tax) quality,

13 Lai Hui-min, *Qianlong huangdi de hebao*, 366-367.

14 For a list of the yearly taxes in gold and silver (*jinyin kuangke* 金銀礦課) received from the various gold refineries in Yunnan etc. see *Da Qing huidian shili* (Guangxu ban) 大清會典事例 (光緒版), eds. Kungang 崑岡 et al., *juan* 243 (chapter '*Hubu · zafu*: *Jin yin kuangke* 戶部 · 雜賦: 金銀礦課 (Board of Revenue · Miscellaneous Tax: Levy from Gold and Silver Mines)' (rep. Beijing: Zhonghua shuju, 1991, vol. 3, 871-879). The fact that part of this gold went to the vaults of the Imperial Household Department can be detected only from the archival documents.

15 *Qianlong chao Neiwufu zouxiao dang* 乾隆朝內務府奏銷檔, vol. 248, 137-138 (QL24/11/19= 6 Jan. 1760) (The First Historical Archives of China, Beijing). These volume numbers refer to the *ce* 冊 of the original accounting reports. A reproduction of all existent accounting reports of The First Historical Archive was published in 2014 (*Qing gong Neiwufu zouxiao dang* 清宮內務府奏銷檔. Beijing: Gugong chubanshe). The 300 volumes cover the years 1723 to 1912.

16 *Qianlong chao Neiwufu zouxiao dang*, vol. 310, 8 (QL37/3/2 = 4 April 1772).

17 Ibid., vol. 228, 60-62 (QL18/12/20 = 12 Jan. 1754).

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each weighing 10 taels; one gold ingot of *weijin* 尾金 ('tail' gold), weighing 2.5 taels; and one ingot of *sasanjin* 撒散金 ('scattered' gold), weighing 5.78 taels. The ingots had been submitted by the governor-general of Shaanxi and Gansu (*Shaan-Gan zongdu* 陝甘總督), Leierjin 勒爾謹, as a product of the local gold refinery. On their standard route, they should have been delivered to the Board of Revenue as ordinary gold tax. But Leierjin had labelled them as 'tribute' so that they were sent directly to the Imperial Household Department.[18]

After Qianlong's conquest of Dzungaria, the 'new territories' of Xinjiang also became a source of gold. In 1766, the Grand Council (*Junjichu* 軍機處) noted down the arrival of 137.5 taels of tribute gold from the areas of Yarkand, Hotan (Hedian 和闐, present Hetian shi 和田市), Shaerhuer 沙爾胡爾 and Kashgar.[19] An additional source was confiscated 'private' gold. According to the regulations in the Qianlong reign, gold, silver and jade were state-owned; any private trade in these materials was prohibited. Between 1784 and 1795, 1,595.24 taels of private gold were confiscated in Urumqi in Xinjiang and sent to the Imperial Household Department.[20]

Gold also came pouring into the Qing court from foreign sources, mainly as tribute gold sent by tributary states and envoys. Korea had been among these tributary states up until the 32nd year of the Kangxi reign (1693), when the Korean king was granted exemption from the donation of 100 taels per year, because he argued that 'gold was not a product of his country'.[21] Among the other tributary states, Annan delivered comparatively regular tributes of gold – 533 taels in 1743, 418 in 1748, 475.5 in 1754, and 418 in 1760. In 1762 and 1765, Annan offered a total of 42 gold bullions weighing 418 taels, and 12 golden ritual artefacts, weighing 115 taels. In 1766, it sent another 533 taels.[22] In 1785, Xianluo 暹羅 (modern Thailand) sent several gold objects as tribute, including a ceremonial document made from one sheet of gold leaf (*jinye biaowen* 金葉表文) and 16 small gold rings.[23]

18 *Qianlong chao Neiwufu yinku jinxiang yuezhe dang*, QL46/1 = Jan. or Feb. 1781. On Qianlong's use of the Board of Revenue as his 'own purse', see Lai, *Qianlong huangdi de hebao*.

19 *Qianlong chao Neiwufu zouxiao dang*, vol. 284, 10-26 (QL31/10/6 = 7 Nov. 1766).

20 *Qianlong chao Neiwufu yinku jinxiang yuezhe dang*, QL46/1 to QL60/12 = Jan. or Feb. 1781 to Jan. or Feb. 1796.

21 He Xinhua 何新華, *Qingdai gongwu zhidu yanjiu* 清代貢物制度研究 (Beijing: Shehui kexue wenxian chubanshe, 2012), 231.

22 *Qianlong chao Neiwufu zouxiao dang*, vol. 284, 26-28 (QL31/10/6 = 7 Nov. 1766).

23 *Qing gong Neiwufu Zaobanchu dang'an zonghui* 清宮內務府造辦處檔案總匯, eds. The First Historical Archives of China, Beijing, and Hong Kong Chinese University Art Museum (Beijing: Renmin chubanshe, 2005), vol. 48, 286-287 (*jishi lu* 計事錄 'record notes'; QL50/2 = March or April 1785).

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The Qing court also maintained tribute relations with several European countries. Some of the items presented contained gold, but there was no direct transfer of 'tribute gold' of any kind. For example, in 1752, King Joseph I of Portugal sent envoys and 28 items as tribute goods, including flintlock rifles and pistols, enamel knives, silver candleholders, pure gold stationery and snuff boxes, gold-threaded brocade, and gold-embroidered textiles.[24]

Even with all these channels of ad hoc and routine sources of gold, the demand ultimately outstripped supply. According to the available 'Monthly receipts and expenditure reports of the Bullion Vaults of the Imperial Household Department' (*Neiwufu yinku jinxiang yongxiang yuezhe dang* 內務府銀庫進項用項月摺檔), a total of 428,909.7 taels of pure gold (*chun jin* 純金) were withdrawn between 1740 and 1795, but only 373,824 taels were deposited, as shown in Chart 5.1.[25]

Chart 5.1 below shows a number of exceptionally high new deposits or withdrawals, especially for the years Qianlong 18 (1753) and Qianlong 44 (1779). In 1751 the high-ranking Manchu official Fuheng 傅恆 (1720-1770) suggested melting down decommissioned gold and copperware stored in the vaults of the Qing Court, including the Ming artefacts and gold books (*jince* 金冊) and seals (*jinyin* 金印) of deceased empresses and consorts. This was carried out, adding 10,919 taels of gold in 86% purity to the Bullion Vaults' storage registers. In 1773 officials of the Imperial Household Department melted down objects in the Eastern and Western Qing Tombs, amounting altogether to 28,992.75 taels of goldware, 31,955.82 taels of silverware, 1,751 catties of copperware, and two gold artefacts from the Imperial Princes of He and Ding (*He Ding qinwang* 和定親王), weighing an additional 443.4 taels.[26] The peak in gold withdrawal from the vault in 1779 was mainly caused by demands in relation to constructions in preparation for the visit of the Sixth Panchen Lama to Rehe 熱河 (modern Chengde) and Beijing, in the wake of the celebration of Qianlong's 70th birthday. To decorate the various buildings of the newly-built Zongjing Dazhao Temple 宗鏡大昭廟 at Xiangshan near Beijing, 13,300.69 taels of first-grade gold were requested from the Bullion Vaults. Because the vaults could not provide the full amount, a total of 13,176.55 taels of second- and third-grade gold, as well as 90%, 80%, and 70% gold was melted and purified, producing 11,820.86

24 *Da Qing huidian shili* (Guangxu ban), *juan* 503 (vol. 6, 827.2).

25 According to the Bullion Vault's 'Monthly receipts reports', all the various gold qualities were exchanged into values of 'pure gold'.

26 *Qianlong chao Neiwufu zouxiao dang*, vol. 319, 175-179 (QL38/4/27 = 16 June 1773). Also see *Qianlong chao Neiwufu yinku jinxiang yuezhe dang*, QL18/7 = July or Aug. 1753, and QL38/6 = July or Aug. 1773.

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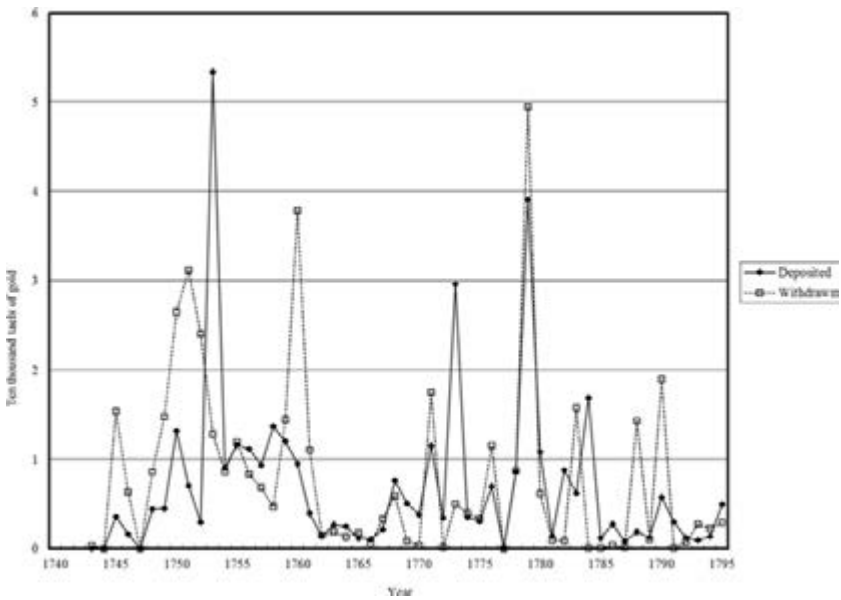
Chart 5.1 Withdrawals and deposits of 'pure gold' in the Bullion Vaults of the Grand Storage Office (*Guangchusi*) in the Qianlong reign



Data collected from the various monthly reports on receipts and expenditure of the Imperial Household Department's Bullion Vaults of the Qianlong period (*Qianlong chao Neiwufu yinku jinxiang yuezhe dang* and *Qianlong chao neiwufu yinku yongxiang yuezhe dang*)

taels of first-grade gold. An additional 4,266.94 taels of tribute gold were collected for this project from the gold refineries in Yunnan or donated from governors, governor-generals and provincial treasures of Guizhou, Sichuan, Shandong, Guangxi, Zhili, and Liang Guang.[27] To prepare for the visit of the Sixth Panchen Lama in Rehe, Qianlong started to build the Xumi Fushou Temple 須彌福壽之廟 in 1779. To fire gild the copper roof tiles and other items, 15,315.35 taels of gold leaf were used for the first gilding, and another 15,315.35 taels for the second gilding.[28] The objects in the Zongjing Dazhao Temple were also gilded two times, thus the figure of 13,300.69 taels of gold mentioned above had to be budgeted and consumed twice. In 1780 a total of 57,232.08 taels were used in these two projects.

The Jesuit missionary Father Giovanni Laureati (1666-1727) suggested the enormous volume of transactions in gold. He stated that 'Chinese gold is not as pure as Brazilian, but its price is very low. When shipped to Europe one

27 *Qianlong chao Neiwufu yinku jinxiang yuezhe dang*, QL44/11 to QL44/12 = Jan. to Feb. 1780.
28 Ibid., QL44/11 = Jan. or Feb. 1780.

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can make 70% profit'. This was not because the Chinese lacked experience in handling and assaying gold. On the contrary, as Laureati further explained to his European colleagues, Chinese artisans were highly proficient in identifying pure gold, silver, and their alloys. But, as gold was only sometimes used as payment and was primarily a commodity rather than a currency, purity was more an aesthetic than a financial issue.[29]

(II) Copper used in the Qing court

The new gilding technology preferred by the Qianlong court required ample supplies of not only gold, but also copper. Before the Qing, most gold-plated objects in China had been silverware; however, silver was much more expensive than copper. According to a guide to prices compiled by the Board of Work (*Gongbu* 工部) in 1736, one catty of copper cost 0.5 tael of silver; one catty of silver could, in turn, buy 32 catties of copper.[30] In the Kangxi reign copper still had to be imported from Japan, but during the Qianlong reign, large copper reserves were discovered in Yunnan, the Chinese province in the far south bordering on what is now Vietnam. This made copper more easily accessible for the court, therefore it is not surprising that there were more gold-plated copper alloys in the Qing than the Ming.[31] However, the Japanese possessed better copper refining technology, so the Imperial Household Department still preferred to use Japanese copper (called 'foreign copper', *yang tong* 洋銅), which was labelled 'water basin copper rods' (*shuicao hongtong tiao* 水槽紅銅條) in its accounting system. The more impure the copper, the more difficult it was to achieve good quality in the fire-gilding process, as the mercury in the gold paste would not evaporate completely, resulting in a surface with an uneven colour and low stability.[32]

The Qianlong emperor himself was aware of the perils of low-grade copper. The record notes (*jishi lu* 記事錄) of August 1744 noted that the eunuch Hu Shijie 胡世傑 had delivered an imperial order: 'Due to the impure

29 Du Hede 杜赫德 (J.-B. du Halde), *Yesuhui shi zhongguo shujian ji* 耶穌會士中國書簡集, trans. Zheng Dedi 郑德弟, Lu Yimin 吕一民 and Shen Jian 沈坚 (Zhengzhou: Daxiang chubanshe, 2005), vol. 2, 117-118.

30 *Jiuqing yiding wuliao jiazhi* 九卿議定物料價值, ed. Board of Work of Qing Court, Beijing, 1736 (rep. in *Gugong zhenben congkan* 故宮珍本叢刊. Haikou: Hainan chubanshe, 2000, vol. 317).

31 A search in the Scripta Sinica Database for gilded copper alloys in the Ming only returned two results, one in *Ming shilu* 明實錄 and the other in Q*ixiu leigao* 七修類稿, http://hanchi.ihp.sinica.edu.tw (accessed via Institute of History and Philology, Academia Sinica, on 11 March 2015).

32 Liu Wanhang 劉萬航, *Jinyin zhuangshi yishu* 金銀裝飾藝術 (Taipei: Xingzhenyuan wenhua jianshe weiyuanhui, 1989), 26.

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copper used, the artefacts made by Deng Bage are coarse and lack rigidity. The issue is to be handed over to Prince Yi 怡親王 and Haiwang 海望 for admonishment. In the future, pure copper must be used'.[33] In a similar case in 1779 the chief supervisor of the Imperial Workshop reported to the emperor that 'the copper used for the *vajra* heads (*chutou* 杵頭) were made from reclaimed copper, which contains glaze and other residues rich in lead, preventing strong bonding between the gilding and the substrate'.[34] Thus, the resource-minded practice of reclaiming or recycling used materials was thwarted by the technical demands of fire gilding.

Qianlong was not the first Qing emperor to look to Japan for a reliable supply of pure copper. As early as 1725, a Copper Refinery (銅吹所, *tongchui suo* in Chinese; *dōfukiya* in Japanese) was established in Osaka, Japan, to process the copper ore into copper bars (棹銅 Chinese *zhaotong*; Japanese *saodō*) for the export market. A bar measured two centimetres in diameter and weighed 300 grams. Each box contained 200 copper bars, weighing a total of 60 kilograms, and bore the lettering of 'Copper Bars for Imperial Use' (*Yuyong zhaotong* 御用棹銅) on the cover (see Figure 5.1). As with gold, the court's appetite for high-grade copper appears to have been insatiable.

Once conveyed to Beijing, copper was stocked together with other less precious metals, such as tin and mercury, in the Ceramic Vaults (*Ciku* 磁庫) of the Grand Storage Office in the Forbidden City to be used for gilding, casting cannons, and other purposes. Between 1743 and 1795 (no record is available for 1777), a total of 1,263,718 catties of copper entered the vaults; during the same period 1,274,725 catties of copper were disbursed.[35] In addition, the Imperial Workshop stocked its own inventory of copper. The annual 'Inventory register of the Imperial Workshops of the Yangxin Palace' (*Yangxin dian zaobanchu shouzhu qingce* 養心殿造辦處收貯清冊) was structured in the same way as those of the Ceramic Vaults, in the form of 'four-column ledgers'.[36] Research into the Imperial Workshops' storage during Qianlong reign reveals that storage data is missing for 24 of the 60 years, as is withdrawal data for 20 years. For the remaining years a total of 265,978 catties in copper deposits and 233,705 in withdrawals were made. Over the years, the Imperial Workshops and the Ceramic Vaults received a

33 *Qing gong Neiwufu Zaobanchu dang'an zonghui*, vol. 12, 301 (QL9/8 = Sep. or Oct. 1744).

34 *Qing gong Neiwufu Zaobanchu dang'an zonghui*, vol. 42, 738-739 ('Zhuluchu 鑄鑪處, Casting Workshop'; QL44/10 = Nov. or Dec. 1779).

35 *Neiwufu Guangchusi Liuku yuezhe dang* 內務府廣儲司六庫月摺檔 (Monthly reports of the Six Vaults of the Imperial Household's Grand Storage Office), *Ciqi ku* 瓷器庫 (Ceramic Vaults) (The First Historical Archives of China, Beijing).

36 For an analysis of their logic and character, see Chapter Three in this volume.

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Figure 5.1 Japanese copper bars (*saodō* 棹銅) and a replica of the box used to send the bars to the Qing empire

Collection of the Osaka Museum (photograph by the authors)

total of 1,529,696 catties of copper and dispensed 1,508,430 catties. A third storehouse for copper was the Bullion Vaults of the Old Summer Palace (*Yuanmingyuan yinku* 圓明園銀庫), but its records were destroyed during the Anglo-French expedition to China in 1860. Chart 5.2 illustrates the amount of copper deposited into and withdrawn from the Ceramic Vaults and the Yangxin Palace. It shows that during the early and late years of Qianlong reign, the amount of copper handled by the Imperial Household Department was quite low. From the 9th year of the Qianlong reign (1744) on, however, the court began to build Buddhist temples in a Tibetan style which were covered with gilded copper tiles, so the use of copper rose steeply. The 1779 peak in copper use was caused by constructing the new Dugang Hall (*Dugang dian* 都罡殿) of the Xumi Fushou Temple – which required 120,163 catties of copper for the roof tiles.[37] As mentioned above, in the same year the Zongjing Dazhao Temple was built and roofed with gilded copper tiles. We do not know the exact number of tiles used, but

37 *Junjichudang zhejian* 軍機處檔摺件, no. 028524 (QL45/10/16 = 2 Nov. 1780) (National Palace Museum, Taipei).

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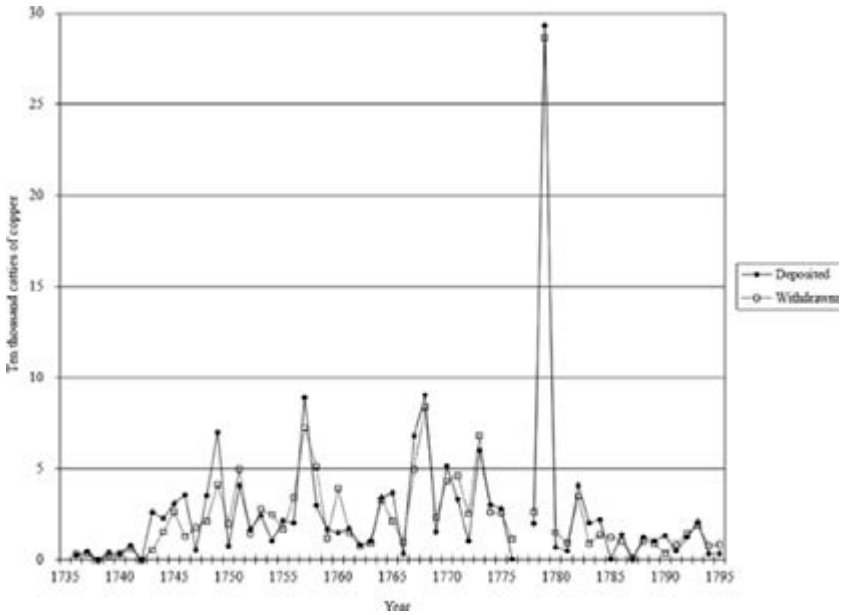
Chart 5.2 The aggregated amount of copper stocked in the Ceramic Vaults and the Yangxin Palace 養心殿 of the Imperial Household Department during Qianlong reign



Sources: 'Monthly Reports of the Office of Privy Purse of the Imperial Household Department' of the Qianlong Reign (*Qianlong chao Neiwufu Guangchusi yuezhe dang* 乾隆朝內務府廣儲司月摺檔). For the Ceramic Vaults no data are available for the 1777; for the Yangxin Palace in sum 24 of 60 years of Qianlong reign lack data.

more than 100,000 catties of high-quality copper might have been needed for this project. These two projects increased the consumption of copper in the year 1779 to over 250,000 catties, in contrast to an average 50,000 catties of copper which the Imperial Household Department handled every year.

The Management of Gilding Artisans

The Imperial Workshops, established during the Kangxi reign, were responsible for manufacturing the artefacts commissioned by the Inner Court. According to *Precedent Cases of Statutes of the Great Qing* compiled in the Guangxu reign (1874-1908), Qianlong gave permission to add another two assistant directors (*yuanwailang* 員外郎) to the Workshops in 1758, one specifically to run the Casting Workshop (*Zhuluchu* 鑄鑪處) and the

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other in charge of manufacturing.[38] In 1778, the staff list of the Imperial Workshops were fixed with three directors (*langzhong* 郎中), two assistant directors (*yuanwailang* 員外郎), one secretary (*zhushi* 主事), one deputy secretary (*weishu zhushi* 委署主事), six vault managers (*kuzhang* 庫掌) and fifteen clerks or scribes (*bitieshi* 筆帖式). The workshops and their personnel were responsible for the manufacture of objects for imperial use, as well as supervising the work involved and managing the associated storehouses.[39]

Five of the workshop's units were related to fire gilding in one way or another: the Casting Works, the Goldwork and Stonework Works (*Jinyu zuo* 金玉作), the Gilding Works (*Dujin zuo* 鍍金作), the Engraving Works (*Zanhua zuo* 鏨花作), and the Intarsia Works (*Xiangqian zuo* 鑲嵌作). In addition to the artisans in the Imperial Workshops, more than 1,000 artisans worked in the Six Vaults of the Grand Storage Office, at least some of whom would have handled gold and silver work. Moreover, fourteen silver refinery workers (*huayin jiang* 化銀匠), seven gold refinery workers (*lanjin jiang* 煉金匠), 24 filigree artisans (*leisi jiang* 纍絲匠) and 22 engraving artisans (*zanhua jiang* 鏨花匠) worked in the Bullion Vaults, either extracting or purifying gold and silver or producing goldware and silverware.[40] Like all the court artisans (*jianei jiangyi* 家內匠役) or salaried artisans (*shiliang jiang* 食糧匠) of the Imperial Workshops, they were recruited from the left and right wings of the upper three banners and their salaries were paid for by the banners to which they belonged.[41] Recruitment and terms of apprenticeship followed those of other craftsmen in the Imperial Workshops. Artisan posts were handed down by hereditary or from master to apprentice, making it almost impossible for outsiders to enter the workshops on a permanent basis. However, just like quality gold and copper, skilled and reliable artisans were also in short supply during the years of peak demand, so the Imperial Household Department also hired contract artisans (*waigu jiangyi* 外僱匠役) from the commercial market. Those with extraordinary skills might have their status converted into a permanent court artisan, whilst others made their daily entrance through the Jingyun Gate (*Jingyun men* 景運門) of the Forbidden City instead of lodging within the palace precinct. Overall, contract artisans were paid more and enjoyed better living conditions than the court artisans. It is interesting to note in passing that the salary of

38 *Da Qing huidian shili* (Guangxu ban), vol. 12, *juan* 1173, 674-1; *juan* 1176, 706-1.

39 Ji Huang 嵇璜 et al., *Qing chao Tongdian* 清朝通典 (Qing dynasty Comprehensive canon of laws and institutions) (Taipei: Taiwan shangwu yinshuguan, 1987), *juan* 29, 2189.3.

40 *Zongguan Neiwufu xianxing tiaoli: Guangchusi* 總管內務府現行條例: 廣儲司, in *Jindai Zhongguo shiliao congkan* 近代中國史料叢刊 (Taipei: Wenhai chubanshe, 1972) *juan* 1, 22.

41 *Da Qing huidian shili* (Guangxu ban), vol. 12, *juan* 1214, Jan. – Feb. 1079.

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contract painters (*caizi jiang* 彩子匠) was higher than that of other artisans, amounting to 1.8 *qian* daily.[42] (See Chapters One and Two for more on the humans that powered the palace machine.)

In most cases regulations and archival documents only talk about 'artisans' (*jiang* 匠) without specifying their profession.[43] Only rare instances afford a glimpse of their positions within the work and craft flows that made the Gilding Works and its gilding projects efficient.[44] One unusual incident, triggered by a disruption to the flow of workers and materials as laid out in the 'Regulations and Precedents', inadvertently revealed how the chain of command in management and staffing of the workshop worked on a daily basis. On the night of the 14th day of the third month, 1773, the Gilding Workshop was burgled. Twelve small miscellaneous copper items for decorating arrow-carrying bags (*sadai* 撒袋), 79 brass screws and one golden ornament on a Buddhist scripture board weighing two *qian* were stolen. The Magistracy of the Household Department (Yamen) interrogated five artisans, including Liangsan Dazi 梁三達子 and Lü Mingde 呂明德, who testified that, before leaving at night, the Vault Manager Wude 五德, along with the artisans had locked the gates of each workshop and the courtyard before leaving. In the morning of the 15th, the artisans arrived and found that while the lock of the Gilding Works remained intact, its windows had been broken. The Magistracy concluded that the artisans should have stayed in the workshop overnight while there were unfinished artefacts inside. The artisans Liangsan Dazi, Lü Mingde and others received 60 lashes of a whip each as punishment for neglecting their storehouse duties. The deputy foremen (*fu cuizhang* 副催長) Xiande 憲德 and Jinjiang 金江 were found guilty for not arranging any security for the unit and for failing to secure the artefacts properly. They therefore also received 60 lashes each for dereliction of duty. One level higher in the administrative responsibilities, the vault manager Wude was accused of having overlooked implementing precautionary measures,

42 Jiang Yasha et al., eds., *Qingdai gongyuan zeli huibian*, vol. 5, 215.

43 The only '*jiang*' that receive special attention and are named in the documents are jade and ivory artisans (*yu jiang* 玉匠, *ya jiang* 牙匠) from the Chinese south and painters (*huahua ren* 畫畫人). Interestingly, the sometimes very high value attached to these painters' work was not reflected in a higher salary. Those paid most generously were the southern jade artisans, who received 12 or even 13 taels of silver per month. See Chi Jo-hsin 嵇若昕, 'Qing zhong houqi (1821-1911) Neiwufu Zaobanchu nanjiang jiqi xiangguan wenti 清中後期 (1821-1911) 內務府造辦處南匠及其相關問題', *Gugong xueshu jikan* 故宮學術季刊, vol. 32, no. 3 (2015): 63-89.

44 Two archival documents dated 1745 and 1746 indicate that fire-gilding workers were differentiated into salary levels (see *Qing gong Neiwufu Zaobanchu dang'an zonghui*, vol. 13, 575 and vol. 14, 365).

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while the foreman (*cuizhang* 催長) Shaode 邵德 and the commandant of Fleet-as-cloud Cavalry (*Yunqi wei* 雲騎尉) Fushan 福山, who were both on shift that night, were found guilty of failing to patrol properly to protect imperial objects. All three were fined one year's worth of salary for neglecting their duties.[45]

The hierarchy of punishment meted out suggests that, at least in security-related matters, the chain of command within an individual workshop consisted of three layers: first, the vault manager (responsible for implementing safety measures) and foreman (on night shift); second, the deputy foreman (in charge of storing artefacts); and third, the individual artisans at work (liable for guarding the artefacts). The responsibility for physically securing the precious materials was shared across the ranks. Outside the workshop structure, the commander of the palace guard was also implicated.

Fire Gilding Techniques and Examples in the Qing Court

As outlined in the Introduction, the palace machine accommodated versatile technological processes and was vitally concerned with the minutiae of material production. The archival documents of the Imperial Household Department record the complicated process of manufacturing gilded copper alloy objects in meticulous details, which involved many preparatory and finishing steps as well as an array of materials and techniques. The first step was producing an object in the desired shape with an utterly smooth surface. In the Department's 'Regulations and Precedents', an often-mentioned technology in relation to gilded objects is a special Tibetan forging technique called *sisa* 鉰鈑. *Sisa* emerged in Tibet as an improvement on the traditional lost-wax technique used to produce Buddhist statues. According to historical metallurgist Yuan Kaizheng, the lost-wax casting technique used in Tibet and Nepal limited the size of Buddhist statues. Most lost-wax statues cast in a single mould were modest in height, about 0.34 metres including the base. Statues whose bases were manufactured separately, those which did not have a base, and those cast in separate parts, were still only about 0.65 metres tall. However, statues of any size could be made using the *sisa* technique, from as small as 0.3 metres high to as tall as 30 metres. However, while the majority of Buddhist brass statues in Tibet were, in fact, made with this technique, small statues were primarily still made from lost-wax

45 *Qianlong chao Neiwufu zouxiao dang*, vol. 324, 152-157 (QL38/12/20 = 31 Jan. 1774).

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casting.[46] Two materials central to the *sisa* technique were glue paste and rosin. An investigation into a traditional metal workshop in modern Tibet by Yuan Kaizheng help us to reconstruct how these materials would have been used in the imperial court of the Qing. The artisan demonstrated how, before carving the details of a copper or brass object, a layer of rosin and glue paste would have been applied from the back to fill the hollow parts, in order to maintain the object's shape during the process. The filling would then be covered by a wooden plate with glue paste applied to the edges of the brass plate. After carving, the rosin glue could easily be peeled off by tapping the plate, then melted and reused repetitively.[47] According to the archival documents of the Imperial Household Department, 100 catties of glue paste were used for every square *chi* 尺 (1,024 square centimetres) of brass plate. With each melting 2 taels' worth would wear off. For every catty of glue paste, 11 taels of rosin and 3 taels of sesame oil were used.[48]

When the desired shape and ornamentation of the object was achieved, an object's surface would be burnished and polished, especially on the carved parts. It would first be filed, then be treated with sand-cloth of various grits, followed by fine sandpaper, and subsequently by charcoal made from tilla wood mixed with clean water. For especially high-quality objects rosin paste would be used as an abrasive, which would be pressed and spread using a steel grater to achieve maximum smoothness and shine.[49]

In the next step welders would join the burnished parts together. Borax flux was pressed into the weld to melt the fusible metal so that it would stick to the refractory metal. For every *chi* of welding seam, one catty of white charcoal, 3 *qian* of borax and 2 *qian* of oxidized silver were mixed to make borax flux.[50] For the actual welding itself, every *chi* of welding seam would require another 8 *qian* of welding agent, 3 *qian* of borax, and 80% of a smith's working day.[51] Another variation of a welding agent recipe can be

46 Yuan Kaizheng 袁凱錚, 'Shilun cangchuan fojiao tongfoxiang waibu tezheng yu qi zhizuo gongyi 試論藏傳佛教銅佛像外部特徵與其製作工藝', *Xibei minzu daxue xuebao* (Zhexue shehui kexue ban) 西北民族大學學報 (哲學社會科學版), vol. 5 (2009): 82-89.

47 Yuan Kaizheng 袁凱錚, 'Shixi cangzu liangzhong chuantong zhuzao gongyi de cunzai---you chuantong tong foxiang zhizuo yinfa de sikao 試析藏族兩種傳統鑄造工藝的存在—由傳統銅佛像製作引發的思考', *Zhongguo cangxue* 中國藏學 (March 2012): 175-185. See especially the photographs on page 181 showing the application of the rosin paste to the back of the copper object and the shaping and carving of ornaments into the surface of the object.

48 Wu Shan, ed., *Zhongguo gongyi meishu dacidian*, 1021.

49 Yanagisawa Koji 柳澤光治 and Jo Ryoku Kinzo 定力金藏, trans. Xisheng 西生, 'Dianqi dujin gongye 電器鍍金工業', *Hebei gongshang yuebao* 河北工商月報, vol. 1, no. 9 (1929): 181-190.

50 *Qingdai gongyuan zeli huibian*, vol. 5, 447.

51 Ibid., vol. 18, 374-375.

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found in the 'Precedents and Regulations of the Brass Unit of the Ceramic Vault of the Inner Grand Storage Office of the Old Summer Palace' (*Yuanming yuan neigong guangchusi ciqiku tongzuo zeli* 園明園內工廣儲司磁器庫銅作則例), which asserts that, for every *chi* of welding seam, one catty of white ash, 2 *qian* of silver welding agent and 2 *qian* of borax were used.[52]

After polishing the object's surface, a gilding stick was prepared. This stick played an important role in the key step in fire gilding, as it was used to ladle the gold paste onto an object and spread it evenly over it. The process started with choosing a copper stick of the right size for the artefact. The front end of the stick would be flattened and raised slightly into the shape of a small shovel. After cleaning and polishing the stick further, a broth made from smoked *Prunus mume* fruits would be applied to its front end and the shovel subsequently submerged in mercury. This process of applying broth and submersion in mercury was repeated a few times until the front end of the stick had accumulated sufficient mercury.[53]

Subsequently, gold threads were placed in a stainless-steel crucible and heated until they turned red, that is, to about 700-800° Celsius. Mercury was then quickly poured into the crucible and mixed with a charcoal stick. The archival documents of the Imperial Gilding Works show that melting 3 taels of gold required one mercury-pouring jar and a whole day's work by a gold-melting worker.[54] Stirring and slowly cooling the substances in the crucible formed a gold amalgam (Au_2Hg), an intermetallic compound. At 122° Celsius the gold paste would consist of 18.66% of Au_2Hg and 81.34% of mercury.[55] A metal technologist working today, Liu Wanhang, explains that the ratio of gold to mercury in weight should be three to eight. Nevertheless, the ratio used by the Imperial Household Department was only one to seven.

The evenly-combined gold paste was then applied on the prepared metal objects using the gilding stick. The objects were subsequently heated to evaporate the mercury, so that only the gold or gold amalgam remained. Heating was another essential step in the process: at room temperature mercury would evaporate too slowly and no diffusion bond would be formed between the substrate and the gold.[56] A higher temperature would mean that a lower percentage of mercury would remain in the gilding – and therefore a higher percentage of gold – but if the temperature went above

52 *Qingdai gongyuan zeli huibian*, vol. 18, 327.

53 Liu Wanhang, *Jinyin zhuangshi yishu*, 26-28.

54 *Qingdai gongyuan zeli huibian*, vol. 5, 417.

55 Wu Yuankang and Chu Rongbang, 'Liudu', 7.

56 Kilian Anheuser, 'Cold and hot mercury gilding of metalwork in Antiquity', *The Bulletin of the Metals Museum*, vol. 26 (1996): 48-52.

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350° Celsius a black copper-oxide layer would form beneath the gilding layer, the thickness of which would increase with heating temperature and duration. That layer would eventually cause the gilding to flake off.[57] Thus, during the evaporation process, the heating was stopped for a short time once white smoke appeared. Subsequently, a brush made from coarse animal hair was used to pat the surface and flatten the gilding. During heating, goldsmiths also had to wipe off the condensation from vaporized mercury from the surface with a cotton cloth. This process encouraged better bonding between the substrate and gold. The gilding would appear after much of the mercury had evaporated.[58]

When the gold amalgam had changed from a whitish-grey to a dull yellow, the object had been sufficiently heated and was ready for a final burnishing and polishing. Having lost more than two-thirds of its weight through the mercury evaporation, the gilding would have a matte appearance and be porous and uneven. An agate or steel burnishing tool was used to create a smooth, shiny surface. The burnished surface was then gently etched with pastes containing chlorides, nitrates, or sulphates to improve its appearance.[59] The 16th-century Italian goldsmith and sculptor Benvenuto Cellini also suggested the use of corrosive agents such as dilute nitric acid.[60] In China, a broth made from smoked *Prunus mume* fruits, soap water, and plain water were used instead to clean the gilded artefacts.[61] A manual used by artisans in the Imperial Workshops, *The Method of Burnishing Copper-alloy Buddhist Statues with Plum Wash* (Foxiang tongtai shenjin meixi jianxin fa 佛像銅胎滲金梅洗見新法),[62] stipulated that 2 *qian* of alkali and 2.5 *qian* of smoked *Prunus mume* fruit were required for every *chi* of gilded

57 Anheuser, 'Archaeotechnology', 58-62.

58 The Imperial Workshops used black charcoal, white charcoal and coking coal as fuel for this process, see *Qing gong Neiwufu Zaobanchu dang'an zonghui*, vol. 33, 687-688 (Guangmu zuo 廣木作, 'Canton wood Workshop'; QL35/1) and ibid., vol. 47, 468-469 (Zhuluchu; QL49/5). Liu Wanhang proposed the use of charcoal, while Wu Yuankang suggested high-quality charcoal or coke, see Liu Wanhang, *Jinyin zhuangshi yishu*, 26-28; Wu Yuankang and Chu Rongbang, 'Liudu', 7.

59 Martin Chapman, 'Techniques of Mercury Gilding in the Eighteenth Century', in *Ancient and Historic Metals: Conservation and Scientific Research,* eds. D. A. Scott, J. Podany, and B. B. Considine (Marina del Rey, Ca.: Getty Conservation Institute – Virtual Library, 1994), 229-238.

60 Benvenuto Cellini, *Due trattati, uno intorno alle otto principali arti dell'oreficeria, l'altro in materia dell'arte della scultura* (Fiorenza: Per Valente Panizzii & Marco Peri, 1568), chapter 26.

61 Liu Wanhang, *Jinyin zhuangshi yishu*, 27.

62 The document is dated QL33/5/4 (18 June 1768), see the facsimile in *Qing gong Neiwufu Zaobanchu dang'an zonghui*, vol. 31, 439-440 (Jinyu zuo 金玉作, 'Goldwork and Stonework Workshop'). See also Li Dou's 李斗 (1749-1817) *Yangzhou huafang lu* 揚州畫舫錄, ann. Wang Beiping 汪北平 and Tu Yugong 涂雨公 (Beijing: Zhonghua shuju, 1961), *juan* 4, 98.

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surface produced, and for 'plum-washing' a third of one artisan's (*meixi jiang* 梅洗匠) working day needed to be calculated into the production costs for every three *chi*.[63]

The two case studies of fire gilding projects and their burnishing and alloying technologies introduced below will reveal how studies of the histories of China's economy and technology can benefit by scrutinizing the copper-related archival evidence from the Imperial Workshops of the Qing court. By accounting for deposits and withdrawals of gold and copper and the additional costs for their use in prestigious projects, these resplendent materials reflect the workings of the palace machine.

(A) The gilded roofs of the Dugang Hall of the Putuo Zongcheng Temple in Chengde

In 1776, a total of 4,838.76 taels of gold were used to gild the roof of the new Dugang Hall of the Putuo Zongcheng Temple 普陀宗乘之廟都罡殿 in Chengde. All the visible parts of the 4,400 pieces of scale-shaped roof tiles for the upper and lower eaves, 532 roof ridge tiles, 616 pieces of decorative end tiles for the rain pipes (*ruyi dishui* 如意滴水), and the decorative monster and animal figures were gilded (see Figure 5.2). In addition, remaking the rain pipes on the roof required 3,142.11 catties of copper as well as 8,678.63 taels of silver for materials and labour costs.[64] Qianlong spent more money on constructing the Putuo Zongcheng Temple at the Qing imperial summer residence than on any other Tibetan Buddhist temple near Beijing, despite its location in the north, beyond the Great Wall. The Qianlong emperor's annual travels to Chengde had established a smooth working connection between centre and periphery of the Qing empire that also allowed for easy transfer of gilding artisans back and forth between workshops in the Forbidden City and the Chengde construction sites. Upon completion, this magnificent temple was comparable to the Potala Palace in Tibet and attracted Mongol princes to make pilgrimages to Chengde.

Also in 1776, a pagoda made from imported dark *zitan* 紫檀 wood was newly built at the South Pavilion of the Putuo Zongcheng Temple complex. Inside the pagoda were 2,160 gilded brass *Amitabha* statues that were 3 *cun* high, 2.3 *cun* wide, and 1.3 *cun* deep. Gilding these statues used up 133 taels of pure gold, 1,869 catties and 12 taels of copper bars, as well as 4,844.11

63 *Qingdai gongyuan zeli huibian*, vol. 18, 239-240.

64 *Qianlong chao Neiwufu zouxiao dang*, vol. 344 (QL41/11/28 = 28 Dec. 1776).

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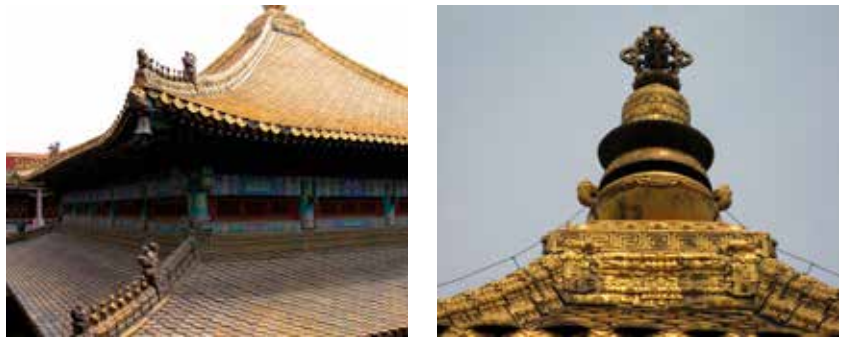
Figure 5.2 The gilded roof of the Dugang Hall of the Putuo Zongcheng Temple, Chengde



Photos taken by the authors, 2008

taels of silver that were needed to pay the workers. In the following year these objects were again gilded twice more, using another 133.6 taels of gold leaf.[65] The many mandalas and pagodas, together with the numerous offerings, European objects and treasures inside the temple complex were extraordinary sights. According to an inventory list compiled in 1789, there were 1,214 decorative objects altogether in the Putuo Zongcheng Temple complex.[66]

In order to enhance their lustre, the gilded statues had to be burnished with a plum wash solution. The standard procedures for this were outlined in the Imperial Workshops' manual, 'The Method of Burnishing Copper-alloy Buddhist Statues with Plum Wash', mentioned above. The method was also used outside the court. The 18th-century writer Li Dou described a similar practice for private Chinese workshops: 'Plum wash artisans burnish gilded brass Buddhist statues with plum wash, using alkali, smoked plum fruits, firewood, and unrefined white cloth'.[67] Safflower, a common Tibetan dye, and gardenias were also used for burnishing, again both being used inside and outside of the court. Another common practice was to add fragrances such as rues, cloves, nutmegs, and alpinia fruits into the solution in what might have been an effort to symbolize the 'five scents' used in the Tibetan

65 *Qianlong chao Neiwufu yinku yongxiang yuezhe dang* 乾隆朝內務府銀庫用項月摺檔 (Monthly expenditure reports of the Imperial Household Department's Bullion Vault from the Qianlong reign), QL41/9, 12 (The First Historical Archives of China, Beijing); *Qianlong chao Neiwufu zouxiao dang*, vol. 346 (QL42/6/15).

66 Xing Yongfu 邢永福 et al., eds., *Qing gong Rehe dangan* 清宮熱河檔案 (Beijing: Zhongguo dang'an chubanshe, 2003), vol. 6, 337-372.

67 Li Dou, *Yangzhou huafang lu*, *juan* 4, 98.

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ceremony of installing Tibetan or Sanskrit mantras or scriptures into a statue (*zhuangzang* 裝臟).[68] The use of Tibetan ingredients and burnishing techniques suggests that some aspects of Tibetan practices had already been adopted for gilding the *Amitabha* statues in the Putuo Zongcheng Temple.[69]

According to modern scholar Luo Wenhua, an expert in Tibetan Buddhist art at the Palace Museum in Beijing, the Qing court did not formally adopt the Tibetan fire gilding method until 1781 when the Imperial Workshops sent an inquiry to Zhongba Hotogtu (Chinese: *Zhongba Hutuketu* 仲巴胡土克圖), a lama residing at the Lhakang Serbo Temple (also called West Gelug or *Xihuang* 西黃 Temple), north of the outer city walls of Beijing, regarding gilding techniques. Hotogtu, who had often served as an art consultant to the Qianlong emperor, replied that gilding was performed by Nepalese (*Baerbu* 巴爾布) artisans using the highest-quality pure gold for plating. If there was any flaw in the plating, a second gilding could be performed and the gilded surface could be burnished with a broth made from Indian madder to achieve a darker golden colour. As a rule, four *li* 釐 of gold were used for one *cun* of surface.[70] Workshop artisans were ordered to learn this technique. A workshop record from 1781 shows that two gilded silver pots were produced in Beijing and shown to the emperor, who ordered them to be gilded for a second time and be burnished further with Indian madder broth. The same treatment was also ordered for a statue of Zongkaba 宗喀巴, a great Tibetan Buddhist teacher.[71] By the late Qianlong reign, the Tibetan techniques of multi-gilding and burnishing with Indian madder water had become a familiar and standard procedure at the Qing court.

(B) Buddhist ritual objects in the Temple of Great Benevolence (Hongren si 弘仁寺; *Sandalwood Temple*) in Beijing

The Temple of Great Benevolence stood at the western bank of Lake Taiye in the imperial park, to the west of the Forbidden Palace (see Chapter Seven

68 Gongbuchabu 工布查布 (Qing 清) trans., *Zaoxiang liangdu jing* 造像量度經 (rep. Taipei: Taiwan yinjingchu, 1956), 49. The five scents named in this text are: Indian sandalwood, agarwood, nutmeg, Bahasa keruing, and tulips. This Chinese translation of this originally Tibetan text was commissioned in the Qianlong reign.

69 S. Wells Williams, *The Chinese Commercial Guide, Containing Treaties, Tariffs, Regulations, Tables, etc., Useful in the Trade to China & Eastern Asia: With an Appendix of Sailing Directions for Those Seas and Coasts* (reprint, Taipei: Ch'eng-Wen Publishing, 1966), 84-85.

70 Luo Wenhua 羅文華, *Longpao yu jiasha — Qing gong zangchuan fojiao wenhua kaocha* 龍袍與袈裟—清宮藏傳佛教文化考察 (Beijing: Zijincheng chubanshe, 2005), vol. 2, 451.

71 *Qing gong Neiwufu Zaobanchu dang'an zonghui*, vol. 45, 2-3, 109-113 (QL46/1 = Jan. or Feb. 1781).

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for this park and the economic use of its lake) at the site of the Hall of Clear Scent (*Qingfu dian* 清馥殿) of Ming times. When in 1665 the building was transformed into a Buddhist temple, a historic sandalwood Buddha statue, whose history is claimed to go back to the year 401 when it was brought to China from Kucha (in present-day Aksu prefecture in Xinjiang), was moved to its main hall. Its previous location had been the Temple of Eagle Peak (*Jiufeng si* 鷲峰寺) in the Xidan 西單 neighbourhood of Beijing. The temple thus acquired its moniker, Sandalwood Temple (*Zhantan si* 栴檀寺).

The sandalwood Buddha was an important artefact, said to have been brought to China by a monk called Kumarajiva, the great translator of Buddhist sutras into Chinese. As time went by, the statue acquired a legendary status that was both political and religious in nature. In 1289, for example, the Mongol ruler Kublai Khan installed the sandalwood statue inside the Temple of Forever Peace (*Dashengshou Wan'ansi* 大聖壽萬安寺) in Beijing and ordered the imperial preceptor (*dishi* 帝師) and monks from the Western Regions to perform twenty sets of Buddhist rituals in its honour.[72] When the Qing established its lama administration at the Sandalwood Temple, it was following this Mongol precedent. It became customary for Mongol princes and Tibetan lama envoys to worship at the temple during their annual visits to Beijing.

As it was clearly not an option to gild the fabled sandalwood Buddha statue, the Qianlong court sought other means to enhance the lustre of the Sandalwood Temple. In 1767, Changzhu 常柱 and others serving at that time as directors (*langzhong* 郎中) in charge of the Six Vaults of the Grand Storage Office reported that 48 small gilded copper-alloy musical bells and 25 gilded bells were to be made to be used in ceremonies in the Sandalwood Temple using first-grade pure gold.[73] Later, in 1774, the Imperial Workshops made several additional items for use at the temple, which included not only costumes for a Tibetan ritual dance (*tiao buzha* 跳布扎), but also 98 small gilded copper-alloy music bells and 120 jingle bells, which consumed 8.57 *qian* of first-grade gold.[74]

72 Cheng Jufu 程鉅夫, 'Zhantan ruixiang ji 栴檀瑞像記 (Note on the Sandalwood Buddha)', in *Xuelou ji* 雪樓集 (rep. Shanghai: Shanghai shuju, 1994), *juan* 9, 16-20. See also the rubbing of a stone inscription with an illustration of the Buddha made by Qin Yingrui 秦應瑞 et al. in 1586 that is stored at the Fu Sinian Library of the Taiwan Academica Sinica, the 'Zhantan ruixiang bingti ji' 栴檀瑞像并題記, and Xue Zhiheng's 薛之珩 note from 1922: 'Jingshi xiao zhantansi bei ji 京師小栴檀寺碑記'. The sandalwood Buddha was first mentioned in 'The Event of Udayana's Making an Auspicious Sandalwood Statue' (*Yuotianwang suozao zhantan ruixiang liji* 優填王所造栴檀釋迦瑞像歷記), written by monk Shiming 十明 from the Kaiyuan Temple in Jiangdu in 932. The text is reproduced in *Dai Nihon Bukkyō zensho* 大日本佛教全書 (Tōkyō: Daihōrinkaku 大法輪閣, 2007), vol. 114, 309-320.

73 *Qianlong chao Neiwufu yinku yongxiang yuezhe dang*, QL 32 (1767).

74 *Qianlong chao Neiwufu zouxiao dang*, vol. 337 (QL40/10/20 = 12 Nov. 1775).

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But it was not only the outside lustre of the gilded bells that show how materials and knowledge from different cultural spheres were aggregated to serve as objects of Qing splendour. The recipes the Imperial Workshops used to cast the resonating bodies of these bells also deserve scrutiny. According to Luo Wenhua, in 1771 both the Changkya 章嘉 Rölpé Dorjé 業西丹畢蓉梅 (1717-1786), who was the Qianlong emperor's preceptor and head of the Gelug lineage of Tibetan Buddhism, and the Jesuit priest Michel Benoist (1715-1774; Chinese name Jiang Youren 蔣友仁) were asked to write down the formulas they had been using to cast bells. The formula eventually used by the Qing court, in Luo's estimation, was a combination of Chinese, Tibetan, and Western formulas.[75]

Table 5.1 Changkya Rölpé Dorjé's formula

Material	Quantity	Percentage
Japanese copper bars	13.87 taels	69.35%
Xian tin (枟錫)	5.95 taels	29.75%
Gold	6 *qian*	0.3%
Silver	6 *qian*	0.3%
Precious stones of three colours (三色寶石)	6 *qian*	0.3%

Table 5.2 Benoist's formula

	Material	Quantity	Percentage
Benoist's formula I	Copper	1 catty（16 taels）	81.97%
	Tin	3.2 taels	16.39%
	Antimony	3.2 *qian*	1.34%
Benoist's formula II	Copper	1 catty（16 taels）	78.74%
	Tin	4 taels	19.68%
	Antimony	3.2 *qian*	1.57%

Benoist especially recommended the addition of antimony, claiming that this would produce bells with a crisper sound. But actually the percentage of antimony he suggested was comparatively low, and his formulas also contained much less tin than that of the Changkya master. After a set of casting tests using different amounts of tin, Qianlong decided that bells with a higher

75 Luo Wenhua, *Longpao yu jiasha*, vol. 2, 401. For the data in Table 5.1 and 5.2 see *Qing gong Neiwufu Zaobanchu dang'an zonghui*, vol. 34, 527-536 (QL36/9 = Oct.or Nov. 1771), and ibid., vol. 48, 143-144 (QL50/2 =March or April 1785).

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percentage of tin produced a better sound. He thus ordered future casting to follow the Tibetan formulas which had a high tin content.[76] Luo argued that the emperor adopted Benoist's formulas to produce the new set of bells.[77]

But the Qianlong emperor was ever inventive. In 1785, the eunuch Changning 常寧 conveyed the following imperial order to the Imperial Workshops: 'Take out the damaged self-chiming clocks and remove their chimes to reclaim the copper. Ask Shuwen 舒文 to use the reclaimed copper to make one large- and one medium-sized Tibetan bell according to the old formula'. Although the order did not specify what the 'old formula' was, from the order's context we can construe it to be the antimony-rich one advocated by Benoist. After evaluating the result, the emperor ordered the following: 'The bells produce only a mediocre sound, and thus shall be given to the lamas at Zhongzheng Hall (*Zhongzheng dian*中正殿) to be recast into ten medium-sized Tibetan bells according to the old [Tibetan] formula, with the addition of gold, silver, and precious stones of three colours'.[78] This incident suggests that in Qianlong's estimation, the Tibetan formula produced bells that sounded better. Table 5.3 provides a summary of the alloy elements in the surface of standard copper bells and the so-called Qianlong *jin'gang* copper bells (*jin'gang tongling* 金剛銅鈴, see Figure 5.3) using modern composition analysis method. A comparison with the formulas listed in Tables 5.1 and 5.2 above shows that, whereas the copper bells seemed to have used the Tibetan recipe, the *jin'gang* copper bells used a recipe closer to the Benoist's Western recipe but no traces of antimony were detected.

Table 5.3 Results of a modern alloy composition analysis on the surface of standard copper bells and *jin'gang* copper bells from the Qianlong period (shown in wt.%, Bal. = balance)

Item	Part	Sn	Zn	Au	Pb	Fe	Cr	Ag	Cu
Copper bell	body	24.01	0.19	–	0.38	0.11	0.03	–	Bal.
	bell handle	–	25.33	–	0.85	0.19	0.06	–	Bal.
Qianlong *jin'gang* copper bell	body	15.42	–	–	1.62	0.12	0.04	–	Bal.
	bell handle (gilded)	–	0.87	97.68	–	–	–	0.16	Bal.
	clapper	–	–	–	–	100.00	–	–	–

Data provided by Dr Donghe Chen 陳東和 from the Science Lab at the National Palace Museum, Taipei (台北故宮科技室) (personal communications, 2018)

76 *Qing gong Neiwufu Zaobanchu dang'an zonghui*, vol. 34, 527-536 (QL36/12 = Jan. or Feb. 1772).
77 Luo Wenhua, *Longpao yu jiasha*, vol. 2, 400-401.
78 *Qing gong Neiwufu Zaobanchu dang'an zonghui*, vol. 48, 143-144 (QL50/2 = March or April 1785).

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Figure 5.3 Qianlong *jin'gang* copper bell

Gilt bronze bell with *vajra* handle made in the 18th century, Qing Dynasty, China. The lotus pattern at the centre of the bell was formed by casting. The head of the handle is connected to a gilt *vajra* with the depiction of a coronated Buddha with a long face, a wide forehead and a straight nose. The details of the crown were finely carved. During the practice, the bell was shaken for spiritual vigilance and joy. Reproduced with permission from National Palace Museum, Taipei.

Conclusion

During the Qing dynasty, the workflow, materials, and artisans of the Imperial Household Department were coordinated by a systematic, codified form of management that was very similar to tasks of the civil government. Construction offices were set up for specific projects and each would issue 'Regulations and Precedents' detailing the amount and price of raw materials, as well as the number and salaries of artisans required to fulfil the commission. These regulations formed the basis of regular reports and facilitated the monitoring of project expenses and progress.

Court artisans' positions in the Imperial Household Department were hereditary, receiving a salary in addition to daily rations of food items. The department also hired a large number of contract artisans who were appointed by the chief contract artisan, given written contracts and a pass to enter the palace precinct. Contract artisans formed guilds and unions, as evidenced by stele inscriptions. For example, artisans from Shanxi formed a Furnace Commerce Guild (*Lufang shanghui* 爐房商會) in Beijing, which was involved in refining gold and silver. Further investigation into how

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the government managed such artisan organizations outside the Imperial Workshops system is needed.

The technology of fire gilding and the forging and casting of copper alloy bodies were fields of expertise in which Qing artisans were particularly innovative. Before the Qing, fire gilding was primarily used on silverware. With the shift to gild copper alloys in the Qing, artisans learned to master gilding irregularly-shaped objects and also solved the issue of flaky gilding layers. The gilding technique was further standardized under the influence of methods introduced from Tibet. To learn better techniques, the emperors invited lamas from Tibet to come to Beijing to teach them how to manufacture numerous Buddhist statues and ritual objects using Tibetan techniques. Two techniques stand out. Firstly, by introducing the *sisa* technique from Tibet, the Qing court could manufacture Buddhist statues in larger sizes. Secondly, the smoked plum broth which had originally been used for burnishing, was replaced by broth made from safflowers or Indian madders that also gave the golden surface a redder appearance. The Qing court also adopted a multi-layered gilding technique from Tibet to achieve smoother surfaces but resulted in a higher cost of investment in the gold used for each object. To conclude, the Qing court's craft in making Buddhist statues and ritual objects was the result of considerable experimentation that involved methods and formulas from divergent knowledge cultures, paired with an enormous need for gold and copper, which the court had to secure sufficient sources of. Ultimately, it was the palace machine that assembled skilled labourers and they, in turn, combined techniques, formulas, and precious metals to realize the Qianlong emperor's numerous resplendent projects.

Translated from Chinese by Ju-Yi Chou; edited by Dorothy Ko

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